SCIENCE

NEW SERIES
VOL. LVIII, No. 1495

FRIDAY, AUGUST 24, 1923

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

SCIENCE

Vol. LVIII AUGUST 24, 1923 No. 1495

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

J. WILLARD GIBBS AND HIS CONTRIBUTION TO CHEMISTRY[1]

Thomas Carlyle expressed the thought that "great men are the inspired texts of that divine Book of Revelations whereof a chapter is completed from epoch to epoch, and by some named History." These words acquire singular significance when applied to him of whom it is my privilege to speak to-day. In a very real sense Josiah Willard Gibbs was one of the most "inspired texts" which adorn the pages of the history of science in America. Unfortunately the process of exegesis has proved both difficult and slow, so that Gibbs did not live to see himself fully understood nor the practical value of his discoveries appreciated.

Josiah Willard Gibbs was born in New Haven, Connecticut, February 11, 1839. He was the fourth child and only son of Josiah Willard Gibbs, professor of sacred literature in Yale Divinity School, and of his wife, Mary Anna, daughter of Dr. Van Cleve, of Princeton, New Jersey. He was descended from Robert Gibbs, the fourth son of Sir Henry Gibbs, of Honington, Warwickshire, who came to this country and settled in Boston in 1658. Henry Gibbs, one of the grandsons of Robert Gibbs, married, in 1747, Katharine, the daughter of Hon. Josiah Willard, secretary of the province of Massachusetts. No fewer than six of the descendants of this couple have borne the name Josiah Willard Gibbs. The father of the subject of this sketch was regarded by his contemporaries as a man of unusual erudition. He was remarkable for his extreme modesty and for the conscientious and painstaking accuracy which characterized all of his published work. One of his colleagues in commenting on his uncompleted translation of Gesenius's Hebrew Lexicon wrote, "But with his unwonted thoroughness he could not leave a word until he had made the article upon it perfect, sifting what the author had written by independent investigations of his own." Thus, not only through inheritance but also by precept and example, the son acquired those habits of thoroughness which marked all of his life-work.

Willard Gibbs was prepared for college at the Hopkins Grammar School, New Haven, and entered Yale in 1854. His brilliance as a student is attested

[1] Presented before the historical section of the American Chemical Society at the New Haven meeting, April 6, 1923.

by the fact that during his undergraduate career he was awarded several prizes for excellence in Latin and mathematics. After his graduation in 1858 he continued his studies in New Haven until 1863, when he received the degree of doctor of philosophy and was appointed a tutor in the college for a term of three years. During the first years of his appointment he taught Latin, and in the third year physics, in both of which subjects he had earned distinction as an undergraduate. In 1866 he went to Europe, spending the winter in Paris, and the following year in Berlin where he attended the lectures of Magnus and other notable teachers of physics and mathematics. After spending the winter of 1868–69 in Heidelberg, where Helmholtz and Kirchoff were then lecturing, he returned to his home in New Haven. Two years later he was appointed professor of mathematical physics in Yale College, a position which he filled with distinction until the time of his death, April 28, 1903.

Professor Gibbs was most widely known for his contributions to the science of thermodynamics, and in all of the standard treatises on this subject his name repeatedly occurs. It is probably true that no one ever displayed greater originality in method of treatment or discovered a larger number of important thermodynamical principles than did Gibbs.

In 1873, when thirty-four years of age, he published in the Transactions of the Connecticut Academy[2] his first paper, entitled "Graphical methods in the thermodynamics of fluids." In this paper the reader will be impressed with the author's inclination to employ geometrical illustrations in preference to mechanical models as aids to the imagination. Gibbs recognized the fact that such models seldom fully correspond with the phenomena they are intended to represent and accordingly sought geometrical illustrations of his equations. In this endeavor he probably has had few if any equals. The late Professor Bumstead in commenting on his skill in this direction wrote as follows:

> With this inclination, it is probable that he made much use of the volume-pressure diagram, the only one which, up to that time, had been used extensively. To those who are acquainted with the completeness of his investigation of any subject which interested him, it is not surprising that his first published paper should have been a careful study of all the different diagrams which seemed to have any chance of being useful. Of the new diagrams which he first described in this paper, the simplest, in some respects, is that in which entropy and temperature are taken as coordinates; in this, as in the familiar volume-pressure diagram, the work or heat of any cycle is proportional to its area in any part of the plane; for many purposes it is far more perspicuous than the older diagram, and it has found most important applications in the study of the steam engine. The diagram, however, to which Professor Gibbs gave most attention was the volume-entropy diagram, which presents many advantages when the properties of bodies are to be studied, rather than the work they do or the heat they give out. The chief reason for this superiority is that volume and entropy are both proportional to the quantity of substance, while pressure and temperature are not; the representation of coexistent states is thus especially clear, and for many purposes the gain in this direction more than counterbalances the loss due to the variability of the scale of work and heat. No diagram of constant scale can, for example, adequately represent the triple state where solid, liquid and vapor are all present; nor, without confusion, can it represent the states of a substance which, like water, has a maximum density; in these cases the volume-entropy diagram is superior in distinctness and convenience.

His second paper, entitled "A method of geometrical representation of the thermodynamic properties of substances,"[3] attracted the attention of physicists throughout the world. He here selects volume, entropy and energy as the three coordinate axes and proceeds to develop the properties of the resulting thermodynamic surface, the geometrical conditions for equilibrium, the criteria for its stability and the conditions for coexistent states, as well as those for the critical state. The importance of this work was quickly recognized by James Clerk Maxwell who, towards the end of his life, constructed a model of such a surface with his own hands and presented a cast of it to Professor Gibbs.

These two papers demonstrated to the world Gibbs's extraordinary powers in the domain of mathematical physics, and presaged the appearance of his most celebrated contribution to scientific literature, entitled "On the equilibrium of heterogeneous substances."[4] This paper, which won for him universal fame, was published in two parts in the Transactions of the Connecticut Academy, the first part appearing in 1876 and the second part in 1878. The author here applied the principles of thermodynamics to the conditions of equilibrium between substances differing not only in chemical properties, but also in physical state. The few attempts which had been made prior to the work of Gibbs to bring chemical action within the scope of the fundamental laws of thermodynamics had proven only partially successful. No broad generalizations, connecting thermal energy and chemical energy, similar to the relations which were known to obtain in the case of mechanical energy, had been established. It was Willard Gibbs who supplied the stroke of genius necessary to the solution of the problem. Not only did he blaze the trail, but in this masterly pub-

[2] Trans. Conn. Acad., 2, 309, (1873).

[3] Trans. Conn. Acad., 2, 382 (1873).

[4] Trans. Conn. Acad., 3, 108 (1876); 3, 343 (1878).

lication he carried the study of the relations between thermal energy and the energy of chemical reaction to a degree of completeness which rivals that of the older theory dealing with mechanical energy. It should be borne in mind that this older theory had to do with a far less complicated subject. As one of his biographers wrote:

The older theory was the work of a number of men whose mathematical deductions were constantly being checked by experiment and who had the stimulus of mutual suggestions from each other's work. Professor Gibbs worked alone in a field in which he had no rivals and no helpers; he published practically all that he had to say upon the subject in a single paper of great length; and there were scarcely any experiments to which he could look for confirmation or suggestion as to his theoretical conclusions. Yet his very numerous results were correct, were of the highest importance, and were extremely general in application. Many things which had been mysteries, and concerning which our ignorance had been confessed by such vague terms as "affinity" or "catalytic action," were in this paper shown to be simple and direct consequences of the two laws of thermodynamics. Relations between facts and laws of chemical action were stated *a priori* which have since been verified by laborious and exact experiments; in fact there is little exaggeration, if any, in the statement that this paper contains, so far as general principles are concerned, practically the whole of the science which is now called physical chemistry and which had scarcely been begun when it was written. Considered merely as an intellectual *tour de force,* there are very few chapters in the history of science which can be compared with this; as an example of scientific prediction it is probably without a rival in the number and complexity of the relations discovered by *a priori* reasoning, in a science essentially experimental.

Notwithstanding the importance of this paper, it was a number of years before its value to the science of chemistry was fully appreciated. The cause of this delay was, in large measure, due to the fact that the author expressed his generalizations in terms of mathematics of which the average chemist of forty years ago was blissfully ignorant.

In 1892 the paper was translated into German by Ostwald and seven years later Le Chatelier translated it into French. In the preface to the German edition, the translator writes:

The importance of the thermodynamic papers of Willard Gibbs can best be indicated by the fact that in them is contained, explicitly or implicitly, a large part of the discoveries which have since been made by various investigators in the domain of chemical and physical equilibrium and which have led to so notable a development in this field. . . . The contents of this work are to-day of immediate importance and by no means of merely historical value. For of the almost boundless wealth of results which it contains, or to which it points the way, only a small part has up to the present time been made fruitful. Untouched treasures of the greatest variety and of the greatest importance both to the theoretical and to the experimental investigator still lie within its pages.

Le Chatelier, in the foreword to the French edition, reminds his readers that

To Professor Willard Gibbs belongs the honor of having created by the systematic use of thermodynamic methods a new branch of chemistry, the importance of which, daily increasing, has now become comparable to that of the gravimetric chemistry created by Lavoisier.

While it obviously lies beyond the scope of this paper to attempt an outline of this remarkable piece of work, it should be pointed out that many of its theorems have served as guides for experimental investigations of fundamental importance, while others have served to classify and explain, in a thoroughly satisfactory manner, the results of numerous researches. No one who is familiar with modern physical chemistry can study this paper without being profoundly impressed by the remarkable clearness with which Gibbs formulated many of its fundamental theorems, despite the fact that so little experimental data was available.

Thus, in his treatment of binary mixtures in which one of the components was assumed to be present in relatively small amount, he deduced the law of dilute solutions which, as is well known, was subsequently derived by Van't Hoff from the experimental data of Pfeffer and Traube.

One also finds a derivation of the exact relationship which obtains between the chemical energy transformed and the maximum electrical energy developed in a reversible galvanic cell. Gibbs clearly pointed out that the total thermal energy of the chemical reaction occurring within a galvanic cell is never completely transformed into electrical energy, unless the temperature coefficient of electromotive force is zero. This same relationship was independently discovered by Helmholtz about four years after the publication of Gibbs's paper; in consequence of this fact its mathematical formulation is commonly known as the "Gibbs-Helmholtz equation."

It was Gibbs who first pointed out, that at the surfaces of dispersed systems, a different concentration is to be expected from that which obtains in the body of the dispersoid. While he did not know or employ the modern concept of dispersed systems, his deductions were of such a general character that they may be applied to the special field of colloids.

Another generalization of interest to the chemist which was first clearly stated in this paper deals with the direction of change of vapor pressure which oc-

curs in the distillation of a mixture of changing composition. This generalization, sometimes referred to as the Gibbs-Konowalow rule, states that a liquid mixture corresponding to a minimum or maximum of vapor pressure at any specified temperature has the same composition as the vapor with which it is in equilibrium.

By far the most important principle enunciated in this wonderfully comprehensive paper, however, is that commonly known as the "phase rule." The Dutch physical chemist, Roozeboom, was the first to recognize the value of this principle in connection with the study of heterogeneous systems, and it is to him that we owe the familiar simplified statement of the theorem as well as numerous illustrations of its applications. The phase rule, as is well known, defines the conditions of equilibrium in a heterogeneous system by the relation between the number of coexisting phases and the number of components constituting the system. It may be briefly stated as follows: A system will be in equilibrium when the number of degrees of freedom is equal to the number of components less the number of phases increased by 2. It may be of interest to mention that Gibbs was the first to employ the term "phase" to signify a discrete portion of matter in which the smallest visible particles are all exactly alike, and which is, therefore, separated in space from every other homogeneous, but dissimilar portion of matter.

The importance of the phase rule in the realm of theoretical chemistry is to-day fully recognized. It has furnished a valuable basis for the classification of closely allied chemical compounds and has proven a trustworthy guide, both in the discovery of new substances as well as in the determination of the range of their stability. Its practical importance is attested by the fact that it forms the basis of modern metallography. The variation of the engineering properties, such as tensile strength, ductility, etc., with varying concentration and varying thermal treatment, can only be satisfactorily elucidated with the phase rule as a guide. The application of the phase rule to the metallurgy of iron and steel furnishes one of the most striking illustrations of its value. The phase rule has proven of inestimable value in connection with the interesting investigations upon minerals and rocks which have been in progress for some years at the Geophysical Laboratory in Washington, while in the ceramic arts and in the manufacture of glass it is destined to play an increasingly important rôle.

In 1879, Gibbs published a paper, "On the vapor-densities of peroxide of nitrogen, formic acid, acetic acid and perchloride of phosphorus,"[5] and a few years later he wrote a series of letters to the secretary of the electrolysis committee of the British Association on "Electrochemical thermodynamics."[6] These papers, together with those previously mentioned, comprise all of his contributions which have a direct bearing upon the science of chemistry.

Besides Gibbs's remarkable achievements in the domain of mathematical physics, he won equally great distinction in the realm of pure mathematics. In his lectures on mathematical physics he became aware of the need for a vector algebra by means of which the complex space relations, so frequently encountered in the study of the theory of electricity and magnetism, could be adequately expressed. To meet this requirement he developed a system of vector analysis for the use of his students. This was at first printed in pamphlet form, but subsequently Professor Gibbs, somewhat reluctantly, consented to its formal publication.

Between the years 1882 and 1889 he published five papers dealing with the electromagnetic theory of light which are regarded by physicists as remarkable for the entire absence of special hypotheses as to the connection between matter and ether.

Professor Gibbs's last work, entitled, "The elementary principles of statistical mechanics," published in 1902, is a masterly exposition of the methods available for the study of systems endowed with several degrees of freedom. This work is said to have opened new vistas to students of mathematical physics.

At the time of his death, in 1903, Professor Gibbs was engaged in the preparation of some additional chapters on heterogeneous equilibrium for a collected edition of his contributions to thermodynamics.

He was the recipient of many honors from learned societies and universities both at home and abroad. Among the societies and academies of which he was a member, or a correspondent, may be mentioned the Connecticut Academy of Arts and Sciences, the National Academy of Sciences, the American Academy of Arts and Sciences, the Royal Institution of Great Britain, the Cambridge Philosophical Society, the Royal Society of London, the Royal Prussian Academy of Berlin, the French Institute, the Physical Society of London, the Bavarian Academy of Sciences and the American Mathematical Society. He received honorary degrees from Williams College, and from the universities of Erlangen, Princeton and Christiania. In 1881 he was awarded the Rumford Medal from the American Academy of Boston, and in 1901 the Copley Medal from the Royal Society of London.

In 1910 a medal was founded in his honor by the Chicago Section of the American Chemical Society to be awarded annually for the best paper or address presented before the section.

[5] *Am. Jour. Sci.* [3], 18, 277, 371 (1879).

[6] Rep. Brit. Assoc. for 1886, p. 388; for 1888, p. 343.

As a teacher, Professor Gibbs is said to have possessed great originality and to have inspired all who came under the spell of his genius. In his classroom there were often revealed

Rich stones from out the labyrinthine cave
Of research, pearls from Time's profoundest wave
And many a jewel brave, of brilliant ray,
Dug in the far obscure Cathay
Of meditation deep . . .

The late Professor Bumstead, who was among those privileged to study under him, writes:

Although long intervals sometimes elapsed between his publications, his habits of work were steady and systematic; but he worked alone and, apparently, without need of the stimulus of personal conversation upon the subject, or of criticism from others, which is often helpful even when the critic is intellectually an inferior. So far from publishing partial results, he seldom, if ever, spoke of what he was doing until it was practically in its final and complete form. This was his chief limitation as a teacher of advanced students; he did not take them into his confidence with regard to his current work, and even when he lectured upon a subject in advance of its publication, the work was really complete except for a few finishing touches. Thus, his students were deprived of the advantage of seeing his great structures in the process of building, of helping in the details, and of being in such ways encouraged to make for themselves attempts similar in character, however small their scale. But on the other hand, they owe him a debt of gratitude for an introduction to the profounder regions of natural philosophy such as they could have obtained from few other living teachers. Always carefully prepared, his lectures were marked by the same great qualities as his published papers and were, in addition, enriched by many apt and simple illustrations which can never be forgotten by those who heard them. . . . No student could come in contact with this serene and impartial mind without feeling profoundly its influence in all his future studies of nature.

As a man Professor Gibbs was singularly retiring. With the exception of those few years spent as a student in Europe, he lived quietly during the academic year in New Haven and passed his summer vacations among the mountains of New Hampshire. He never married but made his home with his sister and her family. Professor Gibbs was unfeignedly modest with regard to his achievements, so much so, in fact, that those who were nearest to him believe that he failed to realize his remarkable mental endowments. He never permitted the importance of his scientific work to interfere with the most trivial duties as an official of the college, and he was ever ready to give generously of his time to those of his students who came to him for advice or assistance. In looking through some of his correspondence recently, a member of his family was particularly impressed by the patience he displayed in endeavoring to help those who were victims of some scientific delusion. In several instances he carried on lengthy correspondence with such people, even though they might not be open to conviction, in the effort to point out where their fallacies lay. Ex-president Hadley said of him, "his plain way of seeing straight where other people's preconceived ideas compelled them to see crooked was characteristic of the man and of his work from beginning to end." In a review of his collected papers which appeared in the *Nation,* the opinion was expressed that "Josiah Willard Gibbs advanced science the world over more than it has ever been given to any other American researcher to do," while one who knew him intimately said of him, "the greatness of his intellectual achievements will never overshadow the beauty and the dignity of his life."

Wherever he be flown, whatever vest
The being hath put on which lately here
So many-friended was, so full of cheer
To make men feel the Seeker's noble zest,
We have not lost him all; he is not gone
To the dumb herd of them that wholly die;
The beauty of his better self lives on
In minds he touched with fire, in many an eye
He trained to Truth's exact severity.

Frederick H. Getman
Stamford, Connecticut

MEDICAL RESEARCH

Many of the less reputable characters of history have found charitable interpreters in our time. M. Anatole France, for example, put the case for Gallio in a very favorable light. But Gallio's contemporary, Simon, alleged to have been a sorcerer but perhaps only a psycho-pathologist with a *flair* for promising therapeutic improvements, remains proverbially infamous. Yet, on the evidence, it seems that Simon was treated a little harshly. He appears to have made to the Apostles a proposition which would surely have seemed neither novel nor heinous to the Academic Registrars of the schools of Athens or Pergamos. One wonders what Peter would have said if Simon the magician, instead of merely offering the Apostles a fee for a course of lectures, had invited them, for a substantial consideration, to devote their entire energies to research into one problem of psycho-pathology named by himself. This at least is certain, that any such proposal in the twentieth century would be welcomed by a large majority of the general public and an important minority of the medical profession as a praiseworthy, public-spirited action to which the offensive word "simony" could not possibly be applicable.

The fact is that a great many sensible and honorable men act as if they believe that "the gift of God may be purchased with money," because this, like most false doctrines, contains an element of truth. The element of truth is plain enough. He who is inspired by a Daemon, can not deliver his message, if his bodily needs are not satisfied. It is rank simony—besides being ridiculous—to believe that the offer of a prize of a million will cause a better play than "Hamlet" to be written or finer researches than those of Pasteur to be accomplished; it is not simony but elementary common sense to believe that a nation which condemns poets and research chemists to hopeless poverty is unlikely to breed Shakespeares and Pasteurs.

These considerations are so obvious, their application in the field of art and literature, to *that* manifestation of the Holy Ghost, so universally admitted, that one must suppose the would-be purchasers of discoveries in the field of medicine do not really understand that the operation of the spirit there is comparable with that of the literary or artistic daemon. Perhaps the reason is that no general readers and very few medical men have any sense of the secular continuity of research and its applications. It is not, generally speaking, true that either the rise or decline of a great killing disease, such as tuberculosis or cancer, exhibits discontinuities certainly referable to some one factor. In the popular sense of the words, there is no disease the "cause" of which is more exactly known than tuberculosis. No scientific communications were ever more exact and complete than those in which Koch described and defined the "cause," the living germ, which is responsible for the morbid changes. One might expect—to judge from popular utterances—that failing a knowledge of the "cause" we should be powerless and having such knowledge, omnipotent in our struggle with tuberculosis. An examination of the annual rates of mortality over the last seventy years dispels any such illusion. The discovery of the "cause" has neither accelerated nor slackened the rate of decline. Bubonic plague, again, ceased to be a prime cause of mortality in this country rather more than 200 years before its "cause" was known; knowledge of its "cause" has not enabled us to conquer it in British India. Scarlet fever is (at present) a small factor of mortality, although its "cause" is unknown. Diphtheria, on the other hand, is an important means of death, but its "cause" has been isolated and exactly studied.

From these facts we may infer that the "cause" of a disease, in the popular sense, is but an incident of research, not the goal of a natural philosopher. The professed enemies of research have indeed inferred from some of these facts that laboratory investigation is worthless and, in drawing that inference, have been as illogical as the enthusiasts who conceive medical research as a true adventure of Sherlock Holmes. If instead of reading *about* the work of great investigators we studied the classics of the science themselves, we should find that the great men never expected to pass at once from the isolation of a "cause" to the conquest of a disease—another overworked metaphor of popular medicine. The importance they attached to the discovery of a "cause" was the power it conferred of simplifying the conditions of study, of making it possible to imitate the operations of nature under controlled conditions. We may freely grant that, in fact, at the present time, scarlet fever is a much less formidable disease than diphtheria, although sixty years ago it was probably a more serious disease and that laboratory research has, so far, given us no aid in the struggle against scarlet fever. Even so, in a very real sense, the terrors of scarlet fever are greater than those of diphtheria. The reason is this. The simplification of the issues which the isolation of the bacillus of diphtheria permitted, the consequent possibility of an experimental study of means of immunization, has given us a method of prophylaxis which, however far from perfection it may be, is demonstrably efficient, so efficient that we may be absolutely certain that such rates of mortality as were not uncommon 100 years ago in large populations will never again be seen in a civilized country. We can make no such confident prediction regarding scarlet fever, we have *no* experimentally suggested prophylactic, good, bad or indifferent. If the type of that disease changes again—200 years ago, in Sydenham's day, it was as mild as it is now, sixty years ago it was one of the great killing diseases of childhood—we shall not be much better off than in the influenza epidemic of 1918 and for the same reason. The instances of anti-typhoid inoculation within the sphere of prophylaxis or of salvarsan, within the field of personal cure, are similar. The epidemiological problems neither of the enteric fevers nor of syphilis have been completely solved by the isolation of the "cause," but in each case the isolation has led to a sensible diminution of human misery. But that the isolation of a "cause" shall in fact lead to a right use of the means of discovery which the isolation has rendered possible, another condition must be realized—there must be a man of genius fit to use the tools placed in his hands. It was not the discoverer of the "cause" of enteric fever who devised the vaccine; Ehrlich did not discover the parasite of syphilis. Lister's work would have been impossible without that of Pasteur, but Pasteur could not have done what Lister did. Everybody, I suppose, realizes the greatness of both Pasteur and Lister; nobody wastes time in disputing which was the greater. In the achievement of any great thing many have cooperated; it is

certain that both Lister and Pasteur would have recalled to our memories many names of men, their intellectual peers, who had a part in the work which we associate with them alone. If we consider only the men prominently associated with the advance of knowledge, of research into the etiology, prevention and treatment of some disease with respect to which we have been successful, we shall rarely, perhaps never, be able to name *one* man who deserves the lion's share of credit. In the history of research into typhoid fever, a glorious history, the names of Budd, Pettenkoffer, Eberth, Klebs, Gaffky and Almroth Wright, stand out. They were men who all greatly surpassed the normal standard of intellectual power, but were trained in different schools, and reached their several ends by different means; all were great investigators, not one was a sleuth hound who, having dramatically arrested the villain of the typhoid mystery, received the reward offered by a medical Scotland Yard.

It is just as futile to offer prizes for specific discoveries in medicine as to offer rewards for the composition of tragedies. Perhaps it is more futile, since the cooperative element in scientific discovery is more prominent. The recognition of that element has induced some to think that while it is wrong to attempt to purchase individuals it is right to try to purchase groups. We hear much of the need for team work. But the success of team work in matters of the spirit depends upon the willingness of individuals to act as a team. Even at football, I have heard, one can not manufacture an invincible eleven by bribing star players to form a side. To the business organizer of scientific victories it might seem obvious that the united forces of the best clinician, the best bacteriologist, the best biochemist, the best epidemiologist and the best men in a dozen other specialities, mobilized on the cancer front, would speedily conquer that redoubtable enemy of the middle-aged and elderly. But unless it can first be shown that all these star performers wish to abandon the investigations in which, by definition, they are successful, and are able to work in team, the obvious expedient begins to look very much like the sorcerer's heresy, to be another effort to purchase the gift of God with money.

One is, therefore, led to state certain facts and to base upon them certain principles.

The facts are that no great discovery stands alone and no important advance in medicine has been the result of working with a single intellectual tool. Upon these facts, we ground certain principles, or rather one general principle. It is that the endowment of research, the general support of all who approve themselves worthy to extend the bounds of knowledge in *any* direction, should be a rule of policy, both personal and collective. The rule of Looking-Glass Garden, that if one wishes to meet the Red Queen one walks the other way, holds in other gardens; its meaning was familiar to the psychologist who said that "the foolishness of God is wiser than men; and the weakness of God is stronger than men." It has been the rule of the most successful endowment of research England has yet seen, that administered by the Medical Research Council. If A. B. submits a program of research which, he conceives, will throw some light upon the etiology of acromegaly, let us say, and the council are satisfied that he knows what he is talking about, they do not say to him, "You are evidently an able young man and your idea is good, but acromegaly is a rare disease and kills its units, while cancer is a common disease and kills its thousands, if you will turn your attention to cancer we will give you twice the grant you ask." They do not presume to control the operations of the human spirit; they know that it is quite possible that a research into acromegaly may teach us more about cancer than a specific inquiry into cancer. The wise old physician who endowed the best scientific foundation of Oxford did not insist that his traveling fellows should study any particular thing; he wished them to study and that was enough.

Those who demand that more money should be devoted to research in one particular field, that more attention should be devoted to influenza, to cancer or to some other particularly important matter and sneer at the allocation of grants for "academic" investigations have forgotten this principle and are in danger of the judgment pronounced upon Simon the sorcerer.

MAJOR GREENWOOD

HILLCREST, CHURCH HILL,
LOUGHTON, ENGLAND

THE CONSERVATION OF MARINE MAMMALS

THE killing of extraordinary numbers of whales from shore whaling stations in different parts of the world during the past few years through the use of improved modern weapons and means of transportation seriously endangers the future of these animals. This situation, coupled with the knowledge of what has occurred in the past to seals, sea elephants and some other marine mammals, has drawn attention to the urgent need of taking steps to bring about proper conservation of all the existing valuable sea mammals.

In the United States, the most active organization gathering and disseminating information on the subject is the Committee on Conservation of Marine Life of the Pacific Division of the American Association for the Advancement of Science, under the leadership

of Dr. B. W. Evermann, Director of the Museum, California Academy of Sciences. The National Research Council, the Bureau of Fisheries of the Department of Commerce, and the Bureau of Biological Survey of the Department of Agriculture, are all taking a lively interest in this subject and desire to assist in developing a practical method of conserving these forms of wild life.

The Natural History Society of British Columbia, under the leadership of its president, Dr. William N. Kelly, is also taking an active part in this conservation movement. In recent correspondence with Dr. Kelly I referred to the difficulty of controlling the taking of whales offshore outside the three-mile limit, to which he replied in part as follows:

Regarding the taking of whales outside the three-mile limit, the Canadian Act (Statutes of Canada, 1914, Chapter 8, Section 8) has provided for this contingency by forbidding any whale not captured in the manner described by the Act being brought ashore to a Whaling Station for reduction into oil and fertilizers, and it also prohibits any whale being brought to a shore station except by the boat from which it was harpooned.

He adds further that he is

inclosing a cutting from Lloyd's List, London, 23d of March, 1923, on the Whaling Research Expedition that is about to leave for South Atlantic Whaling Stations and this will indicate that Great Britain is also alive to the necessity of further restrictions for the conservation of these mammals.

The interesting quotation which Dr. Kelly sends reads as follows:

With regard to the announcement that the Antarctic ship "Discovery" had been purchased by the Crown Agents for the Colonies on behalf of the Government of the Falkland Islands, it is now stated officially by the Colonial office that the vessel is to be employed principally in research into whaling in South Georgia and the South Shetlands, which are Dependencies of the Colony.

There is a very large whaling industry in these Dependencies, and the present amount of scientific knowledge regarding the numbers and habits of the whales is insufficient to enable the industry to be controlled in such a way as to afford security against depletion of the stock. The principal task for which the vessel will be employed is to ascertain the geographical limits of the stock of whales, to trace their migrations, and to form some idea of their numbers and the rate of reproduction. But the expedition will also afford opportunities for adding to scientific knowledge in many other directions, and particularly in oceanography, meteorology and magnetism. The work will be generally on the lines recommended in the report of the Interdepartmental Committee on Research and Development in these Dependencies.[1]

[1] SCIENCE, June 22, 1923, pp. 715–716, contains a more extended notice of this expedition.

The example set by the British Government in beginning definite research work covering the life histories of whales is one that should be extended to cover seals, and other sea mammals, and should be promptly followed by the United States and other maritime nations which are commercially interested in the pursuit of these mammals and in the extended utilization of their products. It is obvious that the present uncontrolled, wholesale slaughter of sea mammals over most of their range and practically throughout the year can result only in their rapid extermination.

During the last century the pursuit of sea mammals was carried on on a great scale and yielded an enormous return in oil, whale bone, hides and furs of fur seals and sea otters. Several species have been nearly or quite exterminated by this pursuit and others will follow without concerted action. Proper control of the hunting of these animals will perpetuate indefinitely the returns from this valuable natural asset.

The success of the fur-seal treaty, whereby, through international action, Japan, Russia, England and the United States safeguard the breeding grounds of the fur seals on the Fur Seal Islands, in Alaska, has been a practical demonstration of the effectiveness of such action. It is to be hoped that a similar treaty between the maritime powers interested may be equally effective in saving the other sea mammals from their threatened extinction.

E. W. NELSON
BUREAU OF BIOLOGICAL SURVEY,
WASHINGTON, D. C.

SCIENTIFIC EVENTS

INTERNATIONAL CONFERENCE ON STANDARDIZATION

A CONFERENCE of the secretaries of national industrial standardizing bodies was held in Switzerland from July 3 to 7. Thirteen countries were represented, including all the more important industrial nations of Europe and America. The sessions were held in Zurich and in Baden.

A leading topic discussed by the conference was the interchange of information between the various national bodies during the development of the work in the different countries. At the first conference held in London two years ago, arrangements were made for the systematic interchange of completed work and, to some extent, of information on work in progress. Experience had shown such an early interchange to be extremely important for the work within the different countries from the national viewpoint alone, and quite irrespective of the question of international standardization.

While it was not possible to overcome all the difficulties existing by virtue of the important industrial considerations involved, very substantial progress was made. It is believed that the steps taken will lead immediately to a substantially increased amount of interchange of information during the earlier stages of standardization work, and that the way has been paved for a much more extensive interchange in the future.

Provision was made for continuing the work of the conference on the many administrative problems of common interest, through a loose-knit continuing organization. An example of such work planned by the conference is the translation of technical terms of special importance or difficulty in standardization work. There will gradually be built up such a vocabulary of technical terms, mainly in English, French and German, but supplemented as far as may be feasible and necessary by the corresponding terms in other languages. Another example is the work undertaken by the conference on the classification and nomenclature of standards.

The conference was attended by the following delegates:

AUSTRIA
Austrian Standards Committee for Industry and Trade .... Jaro Tomaides

BELGIUM
Belgian Association for Standardization .... G. L. Gerard

CANADA
Canadian Engineering Standards Association .... R. J. Durley

CZECHOSLOVAKIA
Czechoslovakian Standards Society .... B. Rosenbaum, R. Matousch, F. Kneidl
Masaryk Academy of Labor, Standards Committee .... Jan. F. Kottland

FRANCE
Permanent Committee for Standardization .... Eug. Lemaire

GERMANY
Standards Committee of German Industry .... W. Hellmich

GREAT BRITAIN
British Engineering Standards Association .... C. Le Maistre

HOLLAND
General Committee for Standardization in the Netherlands .... J. Goudriaan

ITALY
General Committee for Standardization in the Mechanical Industries .... Renzo Curti

NORWAY
Standardization Committee of the Norwegian Industrial Association .... Alf. Erikson

SWEDEN
Swedish Industrial Standardization Committee .... Amos Kruse
Swedish Machine Industries Association .... E. Fornander, H. Törnebohm

SWITZERLAND
Standards Federation of the Association of Swiss Machine Industries .... H. Zollinger

UNITED STATES
American Engineering Standards Committee .... P. G. Agnew

THE BIOLOGICAL LABORATORY OF COLD SPRING HARBOR

ON August 4, a meeting of residents of Long Island and a number of biologists, former workers at the Biological Laboratory, met at Blackford Hall, Cold Spring Harbor, to form a corporation to take over the Biological Laboratory from the Brooklyn Institute of Arts and Sciences. The following are some of the Long Islanders who have joined the corporation: Frank L. Babbott, Robert Bacon, Dr. Richard Derby, Mr. Henry W. DeForest, Mr. Frank N. Doubleday, Dr. George Draper, Mrs. George S. Franklin, Theodore A. Havermeyer, Henry Hicks, Dr. W. B. James, Walter Jennings, Mrs. Otto H. Kahn, R. C. Leffingwell, Nelson Lloyd, W. J. Matheson, Dr. Frank Overton, Mrs. C. C. Rumsey, Mortimer L. Schiff, Henry L. Stimson, John H. J. Stewart, Rosina C. Boardman and others. Among adhering biologists are: Bashford Dean, Harris H. Wilder, H. S. Pratt, A. F. Blakeslee, E. C. MacDowell, Sewall Wright, H. D. Fish, Ezra Allen, John T. Buchholz, L. C. Strong, L. A. Brown, James E. Peabody, Norman MacD. Grier, George B. Jenkins, George F. Sykes, William Smith, Gail H. Holliday, Emilia M. Vicari, E. N. Transeau and J. Walter Wilson. A board of managers composed of eight local members and the following biologists was organized: H. E. Walter, of Brown University; G. Clyde Fisher, American Museum of Natural History, New York; H. M. Parshley, Smith College; Duncan S. Johnson, The Johns Hopkins University; H. D. Fish, University of Pittsburgh; Professor W. W. Swingle, of Yale University, and C. B. Davenport. Steps have been taken to secure the transfer of the laboratory from the Brooklyn Institute to the Long Island Corporation. The board of managers nominated Mr. Reginald G. Harris to act as director for one year during the period of tranfer.

DICTIONARY OF SPECIFICATIONS OF THE BUREAU OF STANDARDS

WORK has been started at the Bureau of Standards on the compilation of material for a dictionary or handbook of specifications for supplies purchased by federal, state and municipal governments and public institutions. This work grew out of a meeting held in May, 1923, of State Purchasing Agents from all over the country, and at which the cooperation of the various states was assured in this matter.

On July 11, a conference was held of various national organizations interested in the preparation and unification of purchase specifications and in their use from the point of view of both the producer and the consumer. This conference was called for the purpose of organizing an advisory committee to cooperate with the Department of Commerce and the National Conference of State Purchasing Agents in the work of formulating purchase standards, specifications and tests. Although no meeting of this advisory committee has yet been held, the various organizations represented are cooperating actively in the actual work of compiling the material for the dictionary, and a great deal of information has been supplied.

Correspondence conducted with the officers of trade associations and the purchasing agents of a large number of municipalities and public institutions has established the fact that all the individuals and groups for which the dictionary of specifications is being prepared will welcome its appearance enthusiastically and cooperate actively in the preparation.

A collection is now being made of all available specifications prepared by the various departments and independent establishments of the federal government and those used by state and municipal governments, public institutions, and the important national trade associations and technical societies. These specifications are being thoroughly card-indexed and classified. Care is being taken to pick out those specifications which are most urgently needed, and due consideration is being given to the attitude of purchasers and consumers toward the existing and the proposed specifications.

George K. Burgess,
Director

THE LOS ANGELES MEETING

The progress of research on the Pacific Coast will be dealt with in an interesting series of papers to be presented at the Research Conference on September 17. The arrangement of this program is in the hands of the local committee which reports the following speakers and subjects:

Professor Ernest C. Watson, California Institute of Technology, on *Research Activities of the California Institute of Technology.*

F. B. Sumner, Acting Director, Scripps Institution for Biological Research, on *The Scripps Institution.*

Acting Dean Herbert J. Webber, University of California Agricultural Experiment Station, Riverside, on *The causes of variation in yield in citrus trees.*

Dr. Laird J. Stabler, University of Southern California, on *Petroleum research.*

The forty-second regular meeting of the San Francisco section of the American Mathematical Society will be held on Tuesday, September 18. Papers will be presented by Professor E. T. Bell, University of Washington; Professor Florian Cajori, University of California; Professor A. F. Carpenter, University of Washington; Dr. Paul H. Daus, University of California; Mr. H. P. Robertson, University of Washington; Dr. Victor Steed, University of Southern California; Professor Harry Bateman, California Institute of Technology, and others. A very interesting meeting is assured.

W. W. Sargeant,
Secretary of the Pacific Division

THE FIFTIETH ANNIVERSARY OF THE PENIKESE SCHOOL

August the thirteenth was celebrated at the Wood's Hole Marine Biological Laboratory as the fiftieth anniversary of the founding of the Penikese school by Louis Agassiz. In commemoration of this school, a bronze tablet has been cast in duplicate with an inscription as follows: "In commemoration of the Anderson School of Natural History established fifty years ago on the Island of Penikese by Jean Louis Rodolphe Agassiz, born 1807–died 1873, the Marine Biological Laboratory, the direct descendant of the Penikese school, erects this tablet, 1923." The original tablet is to be placed on a boulder on the Island of Penikese, and the replica in the Marine Biological Laboratory.

The celebration consisted of speeches by three of the staff of the former Penikese school, Dr. David S. Jordan, Dr. Burt G. Wilder and Professor Edward S. Morse; by one of the former students of the school, Dr. Cornelia M. Clapp; by Professors Hermon C. Bumpus, E. G. Conklin and Frank S. Lillie. It was emphasized that it was Agassiz's methods rather than his conclusions which made him the "master teacher," that he taught his students to get their facts from nature and to think for themselves.

SCIENTIFIC NOTES AND NEWS

The Academy of the Lincei at Rome has elected W. M. Davis, professor of geology, emeritus, at Harvard University, a foreign member in the class of physical, mathematical and natural sciences.

Dr. Harvey Cushing, professor of surgery at the Harvard Medical School, has been elected a foreign corresponding member of the Paris Academy of Medicine.

At the eleventh International Physiological Congress meeting in Edinburgh on July 25 the following members were presented by Sir E. Sharpey Schafer for the honorary degree of doctor of laws: F. Bot-

azzi, Naples; W. Einthoven, Leyden; W. H. Howell, The Johns Hopkins University; J. E. Johansson, Stockholm; A. Kossel, Heidelberg; H. H. Meyer, Vienna; I. P. Pawlow, Petrograd, and C. Richet, Paris.

DR. JOHN F. KIDD, of Ottawa, has been elected president of the Canadian Medical Association.

SIR STEWART STOCKMAN, chief veterinary officer and director of veterinary research to the Ministry of Agriculture and Fisheries, of Great Britain, has been elected president of the Royal College of Veterinary Surgeons.

SIR WILLIAM POPE, professor of chemistry in the University of Cambridge, and a delegation from the British Association for the Advancement of Science attended the forty-seventh Congress of the French Association for the Advancement of Science, which opened at Bordeaux on July 30.

THE Gordon Wigan prize in chemistry has been awarded to R. G. W. Norrish, of Emmanuel College, the University of Cambridge, for an investigation on "The photochemistry of potassium permanganate." The Raymond Horton-Smith prize has been awarded to Dr. A. B. Appleton, Downing College, for an essay on "Morphogenesis of bone," and to Dr. H. W. K. Vines, Christ's College, for an essay on "Certain physiological functions of calcium salts."

DR. J. LASH MILLER, of Toronto, Canada, was the guest of honor at a dinner given at Los Angeles on July 26 by the Southern California Section of the American Chemical Society. Dr. Miller spoke on the "Method of Willard Gibbs in Chemical Thermodynamics."

MAYOR MOORE has appointed Dr. Blair Spencer, assistant director of public welfare, to be director of public health of Philadelphia, succeeding the late Dr. C. Lincoln Furbush.

HOMER N. CALVER has been elected executive secretary of the American Public Health Association to fill the vacancy caused by the resignation of A. W. Hedrich. Mr. Calver is a graduate in sanitary engineering from the Massachusetts Institute of Technology.

DR. GEORGE A. SOPER has been made managing director of the American Society for the Control of Cancer.

IVAR N. HULTMAN has recently been made chemist in charge of operations at the Kingsport plant of the Tennessee-Eastman Corporation. At the close of the war Mr. Hultman became associated with the synthetic organic chemical department of the Eastman Kodak Co.

A NEW cotton boll weevil laboratory has been established by the Federal Department of Agriculture at Florence, S. C., in cooperation with the United States Bureau of Entomology and the South Carolina Experiment Station at that place. Dr. E. N. Winters will be in charge.

THE campaign to investigate the epidemic of fever at Bucuramanga, Colombia, has been placed in charge of Dr. F. A. Miller, who has been directing the campaign against hookworm in that country under the auspices of the Rockefeller Foundation.

DR. MARK BOYD and M. Magoon, of the Rockefeller commission, are in Rio de Janeiro to organize the anti-malaria campaign.

CAPTAIN ROALD AMUNDSEN, leader of the aerial and marine expedition that left Seattle in June, 1922, is on his way to Nome aboard the United States Coast Guard cutter *Bear*, according to word received on August 15.

LIEUTENANT J. R. STENHOUSE has been appointed master of the research ship *Discovery*, which the British Government will send to South Georgia and the South Shetlands regions, in order to obtain scientific evidence bearing on the whaling problem.

PROFESSOR HELLAND HANSEN has left Bergen, Norway, with an expedition aboard the Bergen Museum vessel, the *Armauer Hansen*, on an oceanographic investigation to measure the speed of the Gulf Stream at various depths.

A SCIENTIFIC expedition, *en route* to Point Loma, Calif., sailed from Havre on August 13 aboard the steamer *France* to witness the total eclipse of the sun on September 10. The party includes Charles Le Morvan, astronomer, and Veillet Lavallee.

PROFESSOR M. F. MILLER, chairman of the department of soils of the College of Agriculture of the University of Missouri, is on leave of absence until the beginning of the second semester, January 27, 1924. He is traveling through the corn belt states making a study of the various soils.

DALE S. CHAMBERLAIN, professor of industrial chemistry, Lehigh University, will spend the ensuing year abroad in the study of industrial fuels. He plans to spend some time at the Imperial College of Science and Technology in London.

DR. HERTHA KRAUS, commissioner of public welfare, Cologne, Germany, is visiting the United States to study welfare conditions here.

ABOUT forty American ophthalmologists and laryngologists arrived at Vienna on August 4, with Professor Mackenzie, of the University of Pennsylvania, to

follow special courses of lectures to be given for them at the University of Vienna.

On June 24, the fourth anniversary of his death, the body of Luigi Luciani was transported from Rome to the place of his birth, Ascoli Piceno, accompanied by members of his family and representatives of various scientific and civic organizations. A memorial stone was placed at the house where he was born, and a memorial tablet of marble with a bronze medallion was placed at the house in which he spent his youth. Professor Baglioni delivered the address at the public meeting in the theater. Luciani, distinguished for his research on the heart and brain, was rector of the University of Rome and a senator of the kingdom.

Dr. R. Wiedersheim, emeritus professor of anatomy at Freiburg, has died at the age of seventy-five years.

Professor L. Hiltner, president of the Bavarian Botanical Institute, died on June 6.

Professor J. P. Langlois, of the Paris Conservatoire national des Arts et Metiers, and editor since 1910 of the *Revue générale des Sciences,* died on June 17.

The deaths are also announced of Dr. F. Krafft, professor of chemistry at Heidelberg, aged seventy-one, and Dr. Josef Nevinny, professor of pharmacology at the University of Innsbruck, aged seventy years.

The University of Toronto has appointed a committee consisting of German authorities on metabolism: Krehl, of Heidelberg; F. Müller, Munich; von Noorden, Frankfort-on-the-Main; Minkowski, Breslau, and Strauss, Umber and Fuld, Berlin, with Minkowski as chairman, to study the use and bring about the preparation of insulin in Germany.

UNIVERSITY AND EDUCATIONAL NOTES

The will of Mrs. Mary Clark Thompson, of New York City, contains bequests totalling nearly $1,700,000 to institutions to which she had been in life a liberal benefactress. Vassar, Williams and Teachers Colleges receive $300,000 each. $400,000 goes to the Frederick Ferris Thompson Hospital and $200,000 to Clark Manor House, both being at Canandaigua. Other public bequests are $300,000 to the New York Woman's Hospital and $50,000 each to the New York Zoological Society, Charity Organization Society and the Metropolitan Museum. The Public Library receives her rare books.

From the faculty of Emory University School of Medicine, Atlanta, Hubert Sheppard, Ph.D., professor of gross and applied anatomy, has resigned to accept a position at Rush Medical College, Chicago; Dr. R. Henry Baldwin, assistant professor of physiology, has resigned to join the staff of the St. Louis Hospital; Dr. Ernest B. Sare, professor of pathology and bacteriology, has resigned to become pathologist and bacteriologist to the Georgia State Insane Asylum, Milledgeville, and Dr. John Funke has resigned as professor of pathology to resume private practice in Atlanta.

The following members have been added to the scientific departments of Clark University, and will begin their work with the opening of the fall semester: Dr. Asa A. Schaeffer, who for fourteen years has been head of the department of biology at the University of Tennessee, will join the staff in the department of biology. Dr. Schaeffer has been doing special research work under the auspices of the Carnegie Institution. Dr. Carl Murchison, of Miami University, has been appointed professor of psychology, and will be associated with Dr. Edmund C. Sanford in the conduct of both the undergraduate and graduate studies in that department. Dr. Clarence F. Jones, of the University of Chicago, will be assistant professor in the School of Geography, offering work in economic and commercial geography. Dr. O. E. Baker, of the Department of Agriculture, will be on the staff of the School of Geography during the second semester of the coming year, offering work in agricultural geography and land utilization.

Dr. John E. Guberlet has resigned as parasitologist at the Oklahoma Agricultural and Mechanical College and Experiment Station and has accepted a position in the department of zoology at the University of Washington at Seattle.

Dr. K. Fassler, of Freiburg (Switzerland) has been appointed assistant and reader in mineralogy and geology at Laval University, Quebec.

Professor Roger has been reelected dean of the Paris Faculty of Medicine. Professor Pierre Marie resigned his chair in the faculty on August 1.

DISCUSSION AND CORRESPONDENCE

THE PROFESSOR AND HIS WAGES

Let it be granted as a premise that the college professor neither can nor should be paid what he is "worth" to society. He can not be paid what he is worth because, though a salesman, the goods and services which he sells are of varying and uncertain value, depending much upon the personality of the teacher but even more upon the receptiveness of the student. In a given market a yard and a half of cloth has a definite value, but who can say what is the value of a term and a half of lectures on English literature? Student A may find as much pleasure

from being introduced to the kingdoms of literary imagination as he would from a gift of $25,000; Student B may value the same lectures at thirty cents; Student C, finding them anything but inspiring, may passionately declare, "I'd give a hundred never to have taken that course!" In all the professions one finds the same difficulty. What is the "worth" of a physician? First, tell us what is the value of a human life to its owner? What is the worth of a minister? Well, what is the market quotation on souls?

Nor should the standard be "the higgling of the market." Granting that you can get teachers cheaply, you run the risk of getting among them "cheap" teachers, who are dear at any price. The cheapest doctor is usually a quack; the cheapest lawyer a shyster; the underpaid judge takes bribes on the side; the underpaid engineer will give you the costliest bridge. Service of quality is not to be had over the bargain counter. Who would auction off the presidency of the United States to the man willing to take the lowest salary or offer command of the army to whatever general promised to carry on the cheapest campaign? Whatever be the market rate for teaching, there will be no lack of teachers—of a sort. There may even be among them a few competent men who regard teaching, like preaching, as a divine calling, or who are rich enough from private income to disregard salaries. But taking humanity in the mass, to degrade the standard of living of any occupation is to debase the quality of those who follow it.

The income of college teachers should then be fixed by the general condition of the labor market. This does not mean that an exactly equal salary is requisite to keep the professor from leaving the teaching trade for other lines of salesmanship. The rewards of the entrepreneur are and should be higher than those of the salaried man, because his risks are greater. The teacher, like the editor or the bank clerk, may lose his job, but the only capital he has invested in his business is his time and labor and special training. The publisher or banker or retailer of shoes runs the additional risk of losing the money which he has invested. But if we subtract a proper sum for "risk of capital," there is no further ground for discrimination between the rewards of business enterprise and the income for a profession. It is nonsense to urge that the "social prestige" or the "leisure" or the "pleasantness" of the professorship should be a counterweight for inequality of income. In the United States, at any rate, greater social recognition and prestige goes to the captain of industry than to any other man. The leisure of the college teacher is largely a myth. The pleasantness of his occupation, on the other hand, is undeniable; but who ever proposed to cut down the salary of a railway superintendent or the commissions of a bond salesman because he enjoyed his work? Some of the wealthiest men in the United States are hardly happy away from their offices and ticker tape, and they would enjoy a Latin professorship even less than the Latin professor would enjoy a seat on the stock exchange. Such considerations may be dismissed as altogether beside the point.

We need not assume that the average instructor or professor is as able as a captain of finance. For efficient instruction it would suffice to put the college teacher on a par with a competent bond salesman, general merchant or metropolitan lawyer. Let us compare a typical professorial career with that of a comparably intelligent business man. The following estimates will not be far wrong:

	PROFESSOR BLANK		JOHN SMITH, MERCHANT	
Age 15—	0	(in school)	$500 a year	(office boy)
Age 20—	0	(at college)	$1,500 "	(clerk)
Age 25—	$600	(assistant)	$2,500 "	(salesman)
Age 30—	$1,500	(instructor)	$5,000 "	(salesman)
Age 35—	$2,500	(assistant professor)	$8,000 "	(sales manager)
Age 40—	$3,000	(associate professor)	$12,000 "	(general manager)
Age 45—	$4,000	(professor)	$25,000 "	(profits as owner)
Age 50—	$4,500	(professor)	$35,000 "	(profits as owner)
Age 60—	Retired on half-pay		$25,000 "	(profits as retired stockholder)

Admitting that not all merchants are as successful as Mr. Smith, the fact remains that not all teachers are as successful as was Professor Blank; the table above gives the relative status of two competent men of similar standing in their respective occupations.

A reasonable standard, which would still allow the business man who risks his capital an additional income as insurance for his business risks, would give Professor Blank at least twice his present salary at each round of the academic ladder. To put it concretely, until instructorships pay $3,000 a year and full professorships $8,000 to $10,000, the business world can always outbid the colleges for the services of able men.

One more point should be considered, the exceptional reward for the exceptional man. Business has its millionaires; education has none, though the economic value to society of the work of the research scientist of the highest caliber may be many times

greater than the value of the ablest banker or railroad president. Wealth depends on industrial method; industrial method depends on invention; invention depends on pure science. Now, there is no need of making our Pasteurs or Faradays millionaires; they will do their work without any such reward. But it would be only a meet recognition to pay the outstanding men of science at least as much as a first-class "realtor" or the business manager of a sizable corporation. If each great university should create, say, ten university professorships paying each $20,000 a year, it is unlikely that science would lose many of its ablest men to less important occupations.

It goes without saying that such salaries should be paid only to men of outstanding originality and achievement. Better have the ten university professorships stand vacant for a decade than have their quality lowered, for half their value would depend upon the signal distinction which they would confer. Ordinarily they should go to men in the natural sciences, where research is of the highest importance to human welfare. But one or two might well be awarded to an Emerson or William James in philosophy, or a Lowell or Hawthorne in literature. The mere "scholar" should be well content with an ordinary professorship at $10,000, the highest reward that could reasonably be demanded for efficient industry without imagination.

PRESTON SLOSSON

UNIVERSITY OF MICHIGAN

THE TEMPERATURE OF MINES

I HAVE been recently getting together some figures of the deep temperatures in the mines of the copper country of Michigan and find that apparently a wave of heat, starting some ten thousand years ago, has not reached the bottom of the deeper mines, so that if one takes the temperature at the bottom of the mine and considers how much it drops every hundred feet towards the surface and continues at the same rate to the surface it would imply a surface temperature of not far from freezing. That is to say, the temperatures at the bottom of the mines are adjusted to surface temperature nearly freezing which we may imagine existed under the ice sheet and the rise in temperature since has not worked that far.

Now in the last *Mining & Metallurgical Journal* there appeared an article on the deepest mine in the world, St. Juan Del Rey in Brazil, and there again we find that the temperature at the bottom as compared with that say 5,800 feet down would indicate a much lower surface temperature than really is the case.

Can any one tell me, and here I appeal to those of your readers who are up in other branches of science, whether there are indications in Brazil of a much cooler temperature only a few thousand years ago?

ALFRED C. LANE

TUFTS COLLEGE, MASS.
JUNE 15, 1923

"A HUNDRED POUNDS"

IN SCIENCE of July 27, 1923, Mr. Samuel Russell, referring to my letter of February 23, explains at some length that a hundred weight is not the weight of a hundred pounds but "consists of 112 standard pounds of 7,000 grains, and is divided into 8 stone of 14 standard pounds."

Clearly this solves the problem: "When does a hundred pounds not weigh a hundred pounds?"

I fear Mr. Russell took my letter more seriously than was intended; regarding it as an unprovoked and wanton assault upon the integrity of the defenceless but upright pound. I meant only to call attention to the irrationality of our present legalized weights. For example: 7,000 grains make a pound, a certain kind of a pound; 5,760 make another kind of a pound; 16 ounces make a pound of a certain kind; and we can all say off-hand how many grains there are in such an ounce! (437.5?). But the worst is yet to come. 8,750 grains, which is one eighth of 70,000 grains, make a stone; and 8 stones (a stone being 14 pounds as we all recall) make a hundred weight, which is not as one might suppose 100 pounds, but 112 pounds.

Hence, 2,240 pounds, or 160 stones, make 20 hundred weights or a ton of a certain kind, equal to 20 times a hundred pounds. The coal dealer buys by the hundred weight or 2,400 pounds and sells by the hundred pounds, gaining just 12 per cent. on each weighing. Or we may say that the consumer loses just that much on each weighing. Is not the former an *appreciation* and the latter a *depreciation* of the pound?

ALEXANDER MCADIE

QUOTATIONS

A GREAT BIOLOGICAL LABORATORY

IT is the humble, often little-known toil of an army of investigators that gives to scientific research so great a collective value to humanity. The celebration this week of the fiftieth anniversary of the Biological Institute, now known as the Marine Biological Laboratory, at Woods Hole, draws our attention to the valuable work which scientists have been doing in this institution for many years. When it was founded half a century ago at Penikese Island, the sea was a thing of wonder and mystery. Scientific men knew comparatively little of biological life in the ocean and what was known aroused a desire among them to learn more about the forms of life that existed in the sea.

The establishment of the biological institute marked a revolution in the teaching of biology, and in biological research. The institution was situated on the very edge of the sea, and the students had an opportunity to study the sea, and the creatures in it, as nature, and not some text-book writer, has made them.

Louis Agassiz, the famous Swiss naturalist and zoologist, who made Cambridge his home during the later years of his life, was the guiding star of the institution in the early years of its development. Himself one of the greatest scientists of modern times, with investigations in many branches of science to his credit, Professor Agassiz had long desired to establish a practical school of natural science, to be devoted especially to the study of marine zoology. Through the generosity of Mr. John Anderson, who gave to him the island of Penikese in Buzzard's Bay, together with an endowment of $50,000, his ambition was realized. Professor Agassiz immediately set to work, opened the school, and began his studies in marine zoology. His program at the time seemed a revolutionary one. The students were told to discard the abstract text-books, and substitute for them a first-hand contact with the living forms of the sea. The institution, first known as the Anderson School of Natural History, later became the Marine Biological Institute.

Now the school has won a national and an international reputation. It has added a great deal to our store of knowledge; it has made us better acquainted with the life in the vast ocean depths. This year the institute has 146 students, 168 investigators and 25 instructors, drawn from universities and colleges all over the land, and all inspired with a common desire to add their contribution to human knowledge, no matter how small the individual contribution may be. That is the spirit which wins results in modern science.—The Boston *Transcript*.

SCIENTIFIC BOOKS

Eugenics, Genetics and the Family, being volume one of the Scientific Papers of the Second International Congress of Eugenics. Baltimore, Williams and Wilkins Company, 1923.

Eugenics has diverse associations, and one of the most intimate of these is clearly with genetics and with that study which is being developed in Germany under the title of "Familienanthropologie." The Second International Congress of Eugenics was very fortunate in securing the cordial cooperation of many of the leading geneticists and students of human heredity, as well as anthropologists engaged in the study of family and social groups. Their papers are contained in the first volume of the Proceedings of the Congress. This volume also contains the five general addresses given by Henry Fairfield Osborn, Leonard Darwin, C. B. Davenport, Lucien Ceunot and Lucien March.

As stated, the geneticists are well represented. Professor Jennings gives a paper in his usual clear style on the results of his studies of inheritance in unicellular organisms and Professor McClung on the evolution of the chromosome complex. Bridges and Muller, of the famous Drosophila group of Columbia, write on aberrations in chromosomes and mutation, respectively. Drs. Blakeslee and Belling tell about mutations in the number of chromosomes and its consequences. Professors G. H. Shull and R. R. Gates bring important data from the plant side, and Professors Whiting and Zeleny tell of their work on parthenogenesis and racial mutations, respectively. Mr. R. A. Fisher, of the Rothamsted Experiment Station in England, who is in the first rank of statistical analysts, treats statistically of the consequences of mutation for evolution. Heredity is treated generally by an Algerian zoologist, Legrand, and sex determination by Messrs. A. F. Shull, A. M. Banta and L. A. Brown. Then comes a series of papers relating especially to the genetics of mammals and man. These are introduced by a general statistical paper on mutation in man by Danforth; some papers on the influence of radium and alcohol on mammals by Bagg and MacDowell. Especial studies are given on the inheritance of particular traits, such as mental disorders by Drs. H. A. Cotton, Meyerson and Rosanoff; on tuberculosis by Dr. P. A. Lewis, on cancer by Loeb and Little, on eye defects by Dr. Lucien Howe, on twinning by R. A. Fisher, on finger prints by Professor Kristine Bonnevie (the only woman professor in Norway), on fecundity (in the hen) by C. C. Hurst, on musical traits by Seashore and Miss Stanton. This collection of papers by leading geneticists makes the volume indispensable for the student of genetics in general and human genetics in particular.

In the second part the general paper by Monsieur March on the consequences of war on the birth rate in France will be of great interest at the present time. Inbreeding is treated by Drs. Sewall Wright and Helen D. King from the experimental standpoint, and by Mrs. Ruth Moxcey Martin, Dr. Spinden and Professor W. A. Anderson from the observational standpoint. M. Etienne Rabaud compares the weight of the successive offspring of the same parents. Dr. Banker gives directions for an ideal family history. Dr. F. A. Woods discusses the conification of social groups and Miss Sarah L. Kimball tells of the Mayflower Pilgrims and their descendants. Senor J. J. Izquierdo gives an account of the genealogical history of the Izquierdo family, and Dr. Banker that of the Elihu Burritt group. Two of the descendants of John Humphrey Noyes tell of the Oneida Community experiment. Messrs. A. W. Butler, E. W. Ledbetter, A. H. Estabrook and Mrs. Wilhelmine E. Key de-

scribe some defective families, and Miss Elizabeth Green analyzes the traits of 150 adolescent runaway girls. Finally, mate selection is discussed and analyzed by Professor R. H. Johnson. The book contains also 24 plates, being photographs of the exhibits and giving important data concerning human chromosomes, inheritance of special traits and talents in man and other data of genetical and anthropological interest.

It seems difficult to imagine the accumulation in 450 pages of more concentrated excellence in the general matter treated than is to be found in the papers gathered here. It is clear that every contributor has given his best and has given the results of his own researches. Consequently the volume marks a decided advance in our knowledge of pure and applied eugenics.

Chas. B. Davenport

Eugenics in Race and State. Vol. II of the Proceedings of the Second International Congress of Eugenics. Williams & Wilkins Co., Baltimore, 1923.

The two volumes which embody the proceedings of the Second International Congress of Eugenics held in New York in September, 1921, reflect perhaps as well as anything can the present status of the subject of eugenics. The reader who would gain an idea of the achievements, methods of inquiry, the imperfection of existing knowledge and the difficulties confronting the student in this field will find these volumes very instructive in more ways than one. The second volume entitled "Eugenics in Race and State," which is the subject of the present review, covers a wide range of topics. It includes fifty-five contributions—which are too many for adequate treatment, even in a bulky work of 472 pages.

A few of these contributions have only an indirect bearing on eugenics. Some are more or less obviously efforts for the occasion. Others consist of general and theoretical discussions of the type with which every student of the subject is only too familiar. This is perhaps unavoidable in the proceedings of a large general congress on eugenics. The captious critic might find opportunity for diversion were he disposed to pounce upon every contributor who afforded him an opening. But aside from faults which are almost inevitable in such a collection, the second volume of the proceedings, like the first, contains a large amount of valuable information and many useful suggestions and discussions. Much of the investigation in this field can not boast of the precision which is attained in genetics, whose recent emergence from chaos enables its devotees to look with something of condescension, if not scorn, upon the groping efforts of the eugenist.

The first contribution to the volume is by the well-known author of "Les Sélections Sociales," G. Vacher de Lapouge, who argues for the persistence of European races in a state of relative purity despite the frequent intermixture that apparently threatens to obliterate all racial barriers. This is followed by several other discussions of the mixture of racial stocks. Dr. J. A. Mjoen, perhaps the leading figure in the eugenics movement in Norway, presents a suggestive paper on "Harmonic and disharmonic race-crossings," in which evidence is cited for the conclusion that crossing brings about many disharmonies of constitution and that the mingling of distinct races of man should not be encouraged in the light of our present knowledge. He is careful to state that "we must not draw conclusions from one race-crossing to another. Each race must be examined in relation to another race." In view of the extensive migration of peoples now going on in the world, there are few questions in eugenics of greater importance and of more immediate concern than the one discussed in Dr. Mjoen's paper. One statement made by the author deserves to be especially emphasized: "Our opponents generally say that we should wait to take eugenic measures in *general* and steps against race-crossings *especially* until we have more knowledge. I admit that we need and shall seek more knowledge, *much* more knowledge! But—as our experience up to date points decidedly in one direction it will be safer to turn the matter around and say: *Until we have acquired sufficient knowledge be careful!*" In this, as in other matters of eugenic procedure, advantage is often taken of our lack of precise knowledge to advocate a *laissez faire* policy, but, as I have elsewhere contended in agreement with the statement just quoted, the proper logical application of the argument from ignorance of the effects of racial mixture is to counsel caution, and to warn peoples of the danger of taking a step in the dark.

There are two papers on racial amalgamation in Hawaii and one by M. Fishberg on intermarriage between Jews and Christians. In the latter, attention is called to the following racial trends among the Jews: The increasing intermarriage of the Jews with members of other sects; the increasing proportion of marriages between Jews and Christians, "the less devoted they are to the separative rituals of their religion"; the higher proportion of mixed marriages among Jews who are successful in financial, scientific, literary or artistic endeavors; and the small number of children resulting from mixed marriages. "The Jews are not only robbed of the exceptionally able and talented through intermarriage. Wherever it is carried very far, the Jews are more or less completely absorbed by the Christians around them." Interesting facts concerning the vital statistics of the Jews

are given in the next contribution by R. N. Salaman entitled "Notes on the Jewish problem."

There are two papers on the negro question by two of our most prominent writers on statistics, Professor W. F. Willcox and Dr. F. L. Hoffman. The first discusses the distribution of negroes in the United States, and the second deals with negro-white intermixture and is mainly concerned with the unhappy results of marriages between whites and blacks.

Then follows the opening address of the section on practical eugenics given by Major Leonard Darwin on "The field of eugenic reform." This address is general in scope and characteristically judicious and conservative. After advocating the curtailment of the propagation of the feeble-minded, neuropathic and habitually criminal elements of the community, and discussing the relative merits and feasibility of segregation and sterilization, the author turns his attention to the problem of increasing the amount of superior inheritance in the general population. This can not be so well accomplished, he thinks, by encouraging parenthood in a relatively few of the exceptionally well endowed, as by raising the general level of the whole people. Genius he regards (I believe rightly) as the fortunate product of a number of hereditary factors, and if the general level of native intellect could be raised, "the factors needed for the production of a man of genius would exist in greater numbers." In common with probably most eugenists, Major Darwin recognizes that the present differential birth-rate is tending to breed out the brains of the race. As a counteractive, "there ought to be a great moral campaign against the selfish regard for personal comfort and social advancement, for these aims must, in a measure, be sacrificed on the altar of family life if racial progress is to be insured." He speaks of the encouragement of parenthood by "economic methods," but he offers no economic recipe for increasing parenthood of a desirable kind.

In dealing with the multiplication of inferior types, Major Darwin is inevitably led to consider that troublesome stratum of low-grade humanity lying just above the level of mental defectives, but which we can not deal with by the drastic methods which can be applied to the mentally and morally irresponsible. Major Darwin has no definite remedy for this situation. "I hardly know what to suggest," he says, "in the case of those who, in spite of this [financial] pressure persist in procreation in evil surroundings; and perhaps for the present we should concentrate our attention on the attempt to secure general approval of the desire to lessen the output of children under such circumstances."

I have wondered why Mr. Darwin has made no mention of birth control in relation to this difficulty, especially since he has elsewhere discussed it in connection with this very topic. Perhaps, being a visitor in a somewhat puritanical country, and in the city of Anthony Comstock, he may have been restrained by his regard for the proprieties of the occasion from entering upon a subject surrounded by so much prejudice.

A short paper by Dr. Raymond Pearl on "Population growth" is followed by a more extended discussion by Professor E. M. East on the limits imposed by the productivity of the soil to population increase. Then follows a discussion by S. J. Holmes and J. C. Goff on the selective elimination of male infants as indicative of the action of natural selection during the period of infancy. Mr. O. E. Koegel points out the bad effects, both socially and eugenically, of common law marriages, and Dr. H. H. Laughlin describes the present status of eugenical sterilization in the United States. Dr. William McDougall summarizes the investigations on the relation of native ability and social status, and, in an earlier part of the volume, he contributes a short paper advocating a system of pecuniary rewards for superior types of parents. Dr. L. I. Dublin makes a plea for education for motherhood as a means of counteracting the present dysgenic influence of the higher learning.

Space forbids comment on or even mention of several other contributions to this volume, although some of them contain facts and discussions of real value. Both volumes of the *Proceedings* are issued in attractive form, and they are both indispensable to the students of eugenics.

S. J. HOLMES

SPECIAL ARTICLES

MULTIPLE SEEDED BURS OF XANTHIUM

FROM time to time observations are made which suggest that individual plants among the *Compositae* may possibly revert to remote ancestral floral conditions. Several methods of development of the composite type of inflorescence are conceivable, involving spicate or umbellate types in the ancestry. Through whatever source the present capitulum has been derived, it was undoubtedly originally many flowered, a condition persisting in the great majority of species to-day. In certain regions of this vast assemblage of plants there is a marked tendency to reduction in the number of florets in the head. This tendency reaches its highest expression in such genera as *Xanthium* and *Ambrosia,* in which the florets are reduced to two and one, respectively. A morphological study of the inflorescence of *Xanthium* shows that it is to be considered a reduced structure.[1]

[1] Farr, C. H., "The origin of the inflorescences of Xanthium," *Bot. Gaz.,* 59:136–148, 1915.

About nine years ago the writer obtained from Mr. Crevecoeur, of Onaga, Kansas, some burs of *Xanthium* which contained many seeds to the bur. A brief description of these burs and an account of their origin have been given in another place,[2] under the name *Xanthium canadense*, var. *globuliforme* Crevecoeur, and the suggestion was made that they may represent a reversion to the ancestral type from which the evolution of the two-flowered condition of to-day proceeded. Recently Collins[3] noted a case of floral modification in *Crepis capillaris* which he interpreted as a reversion to remote ancestral condition. In this particular case, the reversion of *Crepis* to a form having bract-like paleae subtending the achenes was preceded by hybridization of two strains originally from Sweden and Holland, respectively. In the F_1 generation one of the hybrid offspring had this presumably ancestral type of flower cluster, whereas in the normal flower head the receptacle is smooth.

Collins believes that the evolution of species in *Crepis* may have been brought about by separation of a large group of interacting factors into smaller groups no longer capable of producing the generalized ancestral condition. Hybridization then may simply bring back the full combination of factors necessary to somatic expression of the ancient character.

In the case of *Xanthium* recorded above, the burs were collected in immature condition, and had been stored in an herbarium for some years before they were placed in my hands for study. Viability had been lost, and the opportunity of studying the morphological, physiological and genetic problems connected with this reversion was lost for the time being.

During the last year burs of this same type, with somewhat fewer florets, have been found again in a habitat hundreds of miles from Onaga, and separated by a time interval of fourteen years. The burs were found by Mr. A. A. Hansen, weed expert and extension worker in the Purdue Experiment Station, near Richland, Rush County, Indiana, during the autumn of 1922, and sent to the Field Columbian Museum for identification. Recognizing their scientific interest, Dr. Sherff called my attention to them, and kindly gave me the burs for propagation. Fortunately the seeds were found to be viable, and a number of vigorous plants are now growing in the garden of the Hull Botanical Laboratory. An abundance of material for study is assured.

It is not yet known whether hybridization precedes the appearance of this reversion or not, nor even whether it is a case of reversion. The original information furnished by Crevecoeur indicated that the plants might be hybrids. The writer desires additional field data regarding the frequency with which this peculiar modification arises in nature. The infrequency with which it is reported may be due in part to lack of close observation in the field. Field botanists, ecologists, naturalists and students of local floras from all parts of the United States are requested to observe the *Xanthium* population in their respective localities, and to communicate to me the finding of burs which show a many flowered capitulum.

These modified burs may be recognized by the replacement of the two terminal beaks of the bur by a double circlet of beaks surrounding a depression in the outer end of the bur. The photographs reproduced in the paper cited will assist in identification of burs. Any information regarding the occurrence of this type in nature will aid very materially in its interpretation.

CHARLES A. SHULL
THE UNIVERSITY OF CHICAGO

[2] Shull, Charles A., "An interesting modification in Xanthium," *Amer. Jour. Bot.*, 3:40–43, 1917.

[3] Collins, J. L., "Reversion in Composites," *Jour. Hered.*, 12: 129–133, 1921.

THE IOWA ACADEMY OF SCIENCE II

Botany

The flora of the Olympic peninsula, Washington: ALBERT B. REAGAN.

The Pyrenomycetes or Black Fungi of Iowa: JESSIE PARISH.

The leaching of calcium from soil: WINFIELD SCOTT.

The relation of moisture content to the viability of seed corn: WINFIELD SCOTT.

Notes on the flora of Pine Creek Hollow, Dubuque county: L. H. PAMMEL.

Notes on plants at Whitehall, Michigan: L. H. PAMMEL and R. I. CRATTY.

The Burdock rust (Bullaria Bardanae) in Iowa: GUY WEST WILSON.

Polygonum in Iowa: G. L. WITTROCK. Examination of material in the herbaria of Grinnell, Ames and Iowa City reveals the presence of twenty species in the state. The distribution of each species is given.

Cuscuta in Iowa: G. L. WITTROCK. Examination of material in the herbaria of Grinnell and Ames reveals the presence of eleven species in the state. The distribution of each species is given, and a key to the species.

Citation of authority for Latin names: HENRY S. CONARD. The writer insists that for all persons who are not specialists in systematic botany, citation of the author of a name is meaningless. It is much more significant to name the manual or monograph consulted in determining the names.

The importance of the aerial environment in the growing of wheat in nutrient solutions: A. L. BAKKE. Growing wheat at three different seasonal periods, it has been

found that there is considerable variation in the composition of the culture giving optimum growth. The kind of culture is dependent upon the kind of environment under which the plant is grown. An optimum or "best" solution can be so regarded only according to the particular environment under which a plant is grown.

Plant observations in the field: B. SHIMEK.

Studies on the cytology of Melilotus alba: E. F. CASTATTER. The paper will cover the development of the anther, the behavior of the pollen mother cells, with special reference to the reduction of the chromosomes, and the formation of the pollen grains.

Some introduced plants in Fiji: ROBERT B. WYLIE.

The arborescent flora of a midwest farmstead: T. J. FITZPATRICK. The paper contains the results of observations made during August, 1922, in Buffalo county, Nebraska, upon dooryard and forestry plantings with respect to the prevalent environmental conditions.

The task of the botanist in Florida: THOMAS H. MACBRIDE. Threefold: 1, to understand the wonderful flora of the peninsula; 2, to save and conserve the forest resources of the state; 3, to aid the entomologists and chemists in the culture of citrus fruits.

A collection of Fiji and New Zealand Myxomycetes: THOMAS H. MACBRIDE.

Some Polypores found in Henry county: MARYE CARNAHAN.

Methods of modeling the Agaricaceae: KATHRYN GILMORE.

A study of growth of trees as revealed by the annual rings: MAX W. VAN HORN.

The germination of some trees and shrubs, and the juvenile state: L. H. PAMMEL and CHARLOTTE M. KING.

A day in Muskogee, Oklahoma: L. H. PAMMEL.

The occurrence of the dwarf Juniper (Juniperus horizontalis) near Rockford, Iowa: L. H. PAMMEL. A number of years ago Mr. Clement Webster and C. Harold Brown, of Charles City, sent to the writer a specimen of what he determined to be the above juniper. He wanted to make sure that the plant was not introduced. He had an opportunity last summer to not only confirm the identification previously made, but to determine that the plant was a native to the region; so far as he knows, the only locality in Iowa. Robinson and Fernald give the distribution as Newfoundland to New England and New York and northern Minnesota. This juniper is entirely out of its range. There are a couple dozen clumps on a clay hillside with a north exposure. Lime creek is about a quarter of a mile away to the north. The associated plants are interesting: the western woolly thistle (*Cirsium canescens*), the most eastern locality in Iowa; also *Petalostemum violaceum, Astragalus canadensis, Panicum virgatum* and *Phlox pilosa*.

The structure of some nectar glands of Iowa honey plants: WILLIAM S. COOK.

Geology

An excellent example of high clay bank erosion in Lee county, Iowa: BEN H. WILSON.

White clay in Clinton and Jackson counties: S. L. GALPIN.

Fossil Annelid jaws from the Devonian of Iowa: WALTER V. SEARIGHT.

The occurrence of a black bituminous shale near Palo, Linn county: GLENN S. DILLE.

An unusual well record in northwestern Iowa: JAMES H. LEES. The well recently drilled for the town of Holstein is remarkable in showing in its lower part, beneath the St. Peter sandstone and the Prairie du Chien limestone, a rather thin series of shales with an intercalated sandstone layer, which probably represents the great Cambrian sandstones of the Mississippi valley. Below these is about forty feet of somewhat quartzitic sandstone, a part of which is very red. This may correspond to the thick body of the Sioux quartzite, which is exposed less than a hundred miles to the northwest. Beneath this bed is a pink hard granite, which was penetrated for thirty feet. The total depth of the well is 2,040 feet, from a curb altitude of 1,439 feet.

Lake Huron winter beach forms: MAX LITTLEFIELD. Accumulations of pebbles and cobbles piled on a Lake Huron beach by wave action in re-entrants of the fring ing shore ice.

Phosphate in Iowa limestones: JOHN E. SMITH.

Experiences of a well digger: JOHN M. LINDLY.

The geographic distribution of Iowa Devonian echinoderms: A. O. THOMAS. Distribution of species is practically limited to the confines of the state and a given species seldom ranges through more than one formation. The genera in most cases have considerable geographic range, being found not only in the Devonian of neighboring states but some of them in more remote parts of the continent. *Arthracantha* and *Agelacrinus* are examples of the latter, while *Dactylocrinus* and *Xenocidaris* are found in the Devonian of Europe.

Some giant Stromatopora from near Iowa City, Iowa: A. O. THOMAS. A recently opened quarry in the Cedar Valley limestone has been the source of colonies of Stromatopora over a foot in diameter. They are of the multilamellar type common in the Iowa Devonian, but hitherto represented in this locality by individuals only a few inches in diameter.

Fossils from an outcrop in Des Moines, Iowa: A. O. THOMAS. The pit of the Capitol City Clay Company is typical of several highly fossiliferous exposures of the Henrietta beds in Des Moines and vicinity. Brief descriptions and illustrations of the commoner species, it is hoped, will stimulate local students and collectors.

The eruption of Mt. Tarawera, New Zealand: A. O. THOMAS. A visit was made by the writer in July, 1922, to the area covered by the ejectamenta of the 1886 eruption. The debris of that eruption was spread over an area close to 6,000 square miles. About one fourth of this area was thereby rendered unsuitable for agriculture. Except in the immediate vicinity of the mountain, natural and artificial re-forestation have quite reclaimed the region. Near the south end of the Tarawera rift violent mud eruptions have occurred within the last five years. Observations on the geysers at Waimangu and Rotorua also are noted.

Numerical limitations to glacial epochs: CHARLES KEYES. The five glacial till sheets which Iowa presents

critically demonstrate a periodic phenomenon that doubtless has some cosmical cycle for basis. Beginning with the Nebraskan till which extends farthest south in Kansas and Missouri, later tills are successively less extensive. This circumstance suggests that if there were successive retrogression, there should also be successive progression, until a maximum extension was reached in the Nebraskan till. In recent deep excavations in Des Moines under the ancient, south-facing bluff of the Raccoon River, where traces of such old tills would be most likely to occur and be protected, there appear to be remnants of at least two tills older than the Kansan drift which overlies them. Pre-Kansan tills need careful scrutiny with the idea in mind of a possible multiple nature.

Stratigraphic position of Sweetland black shales: CHARLES KEYES. When the black shales of Louisa County were first described and designated the Sweetland Formation there was ascribed a Devonian age to them. Since the appearance of the report these shales were more properly correlated with the black shales occurring farther south in Missouri, best assigned to the Carboniferous period. Recently a new interest is awakened in this formation. It has to be considered in its relations with similar shales now known to extend to the eastward to Ohio, and southeastward to Alabama. Through all this wide range there are many names attached and the new problem has to do with the adjustment of them in no less than nine states.

Water table of the loess: CHARLES KEYES. Writers on the loess frequently note the presence of curious ferruginous bands, two or three inches in thickness, traversing the deposits obliquely. So far as he is aware no one alludes to their possible cause. In certain extensive street grading in Des Moines a short time ago these "iron bands" were unusually well developed. They were plainly subparallel to the present surface of the ground and about eight feet down. They passed at this depth from the Wisconsin till above, through the loess bed in the middle, into the Kansan drift beneath. These bands manifestly marked the position of the old groundwater level before the hills were tapped by various excavations and the ground waters lowered or drained off. Old wells long since filled up and forgotten in the growth of the city but unearthed by the recent cuttings all go down to this old iron band.

Apparent fossil fruits from the Fort Union beds: M. A. STAINBROOK.

Chemistry

Iowa Section, American Chemical Society

An interesting deposit of lime: F. C. STANLEY.

Electrometric titration of chlorate, bromate, iodate with titanous ion: W. S. HENDRIXSON and N. L. CRONE. These substances may be thus directly determined, and the voltage curves show that the reduction takes place in two phases.

The incomplete oxidation of sulfite by dichromate: W. S. HENDRIXSON and P. W. HUSH. The dichromate reduced was four per cent. too low, probably due to formation of dithionate as in the action of sulfurous acid on permanganate.

The decomposition of double salts: NICHOLAS KNIGHT.

Substances dissolved in rain and snow: H. S. FRIES and NICHOLAS KNIGHT. A continuation of the work on the various substances dissolved in rain and snow. Forty-one samples of rain and snow were collected and analyzed from September 19, 1921, to June 2, 1922, inclusive. There was a total precipitation equivalent to 17.46 inches of rain, calling 12 inches of snow equal to an inch of rain. It was found that the precipitation of the latter part of October and the latter part of April happened to be identical. The nitrogen in nitrates and nitrites, free and albuminoid ammonia, chlorides and sulphates were determined.

Concerning the action of urease: E. W. ROCKWOOD.

The reaction of nitrogen trichloride with some unsaturated hydrocarbons: G. H. COLEMAN and ELIZABETH PICKERING.

Further observations and summary of results obtained in the study of the migration of acyl from nitrogen to oxygen: L. CHARLES RAIFORD.

(a) *Methods of acylation and effect of relative weights of acyl radicals:* J. R. COUTURE.

(b) *Effect of relative positions of amino and Hydroxyl Groups:* E. P. CLARK.

(c) *Effect of acidity of acyls:* H. P. LANKELMA.

(d) *Behavior of bases derived from condensed nuclei:* J. C. COLBERT.

Studies in orientation, I.: L. CHAS. RAIFORD and C. CARROLL HILMAN.

A study of the equilibrium between iodine and barium iodide in aqueous solution: J. N. PEARCE and W. G. EVERSOLE.

A study of the equilibrium between bromine and strontium bromide in aqueous solution: J. N. PEARCE and J. V. O'LEARY.

Further work on the equivalence of the activity of the halide ions: J. N. PEARCE and A. R. FORTSCH.

A sensitive test for copper in the electrolytic determination of copper: STEPHEN POPOFF and C. W. TUCKER.

Critical study of standardization of solutions used in iodimetry: STEPHEN POPOFF and J. H. WHITMAN.

The electrometric titration of tin: STEPHEN POPOFF and F. L. CHAMBERS.

A solubility survey—solubilities in sulfur dioxide.

III. *Solubilities in the 5th series of the periodic system at 25° C.:* I. C. BROWN and P. A. BOND.

IV. *Solubilities in the 8th series of the periodic system at 25° C.:* S. H. BOBROV and P. A. BOND.

V. *Solubilities in the 4th series of the periodic system at 25° C.:* F. W. PERISHO and P. A. BOND.

Notes on the mechanism of methylation reactions: HARRY F. LEWIS, SHERMAN SHAFFER and RUSSELL MORGAN.

The tetraalkylthiuramdisulphides: HARRY F. LEWIS and SHERMAN SHAFFER.

Synthetic hypnotics in the barbituric acid series: ARTHUR W. DOX.

The effect of impurities on the physical properties of oxychloride cements: BEN H. PETERSON.

JAMES H. LEES,
Secretary